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Editorial

Feeding the Future: The Role of Aquaculture in the Tropics

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In recent years, the aquaculture and fisheries sectors have witnessed significant global trends that reshaped how we approach seafood production. According to the Food and Agriculture Organization (2022), capture fisheries contributed 90 million tonnes (51%), and aquaculture 88 million tonnes (49%). Of the total production, 63% (112 million tonnes) was harvested in marine waters and 37% (66 million tonnes) in inland waters. These trends reflect the dynamic interaction between environmental, socio-economic, and technological factors. However, the increasing demand for seafood and declining wild fish stocks have driven a notable shift towards aquaculture to meet global protein needs, implying the pivotal role that aquaculture is playing in enhancing food security and reducing pressure on natural ecosystems.

Traditional aquaculture species, such as carp and tilapia, are complemented by a broader range of species, including marine fish, mollusks, and seaweed. This species diversification contributes to dietary variety and mitigates risks associated with disease outbreaks and market fluctuations (Troell *et al.* 2014). The increasing research on new species incorporation in aquacultural practices plays a significant role in this trend. Scientists worldwide search for new methods, systems,

and ingredients for low-cost diets; the development of precision aquaculture (integration of data analytics, sensor networks, and automation) has enabled producers to optimize feed usage, monitor water quality, and enhance fish health (Soto *et al.* 2020). These developments improve resource efficiency and reduce environmental impacts.

Aquaculture production varies significantly by region, influenced by climate, geography, and market preferences. Asian countries, particularly China, have traditionally dominated global aquaculture production, driven by their favorable environmental conditions, large domestic markets, and expertise. However, other regions, including Europe, North America, and Latin America, have also witnessed growth in aquaculture production. In this regard, aquaculture in tropical areas is playing an important role in the new global aquaculture trends. Producers in warm areas of Asia (China, Thailand, Indonesia, Vietnam, Bangladesh, India, and the Philippines); Africa (Egypt, Nigeria, Uganda, Zambia, South Africa, and Kenya); Latin America (Colombia, Brazil, Ecuador, and Mexico); and the Caribbean (Jamaica, Trinidad and Tobago, and Cuba) are currently engaged in commonly farmed species, including tilapia, catfish, carp, shrimp, prawns, oysters, mussels, and various types of seaweeds. New species are being incorporated, particularly in Asia, and research is targeting emerging native species with high potential, including freshwater and marine organisms. This practice involves diverse systems such as ponds, tanks, cages, or raceways. The advantageous warm water temperatures in tropical regions provide favorable conditions for year-round aquaculture production, allowing for multiple harvests per year and reducing the dependence on seasonal cycles.

The practice of tropical aquaculture has gained a reputation due to its potential for economic development, meeting the increasing global demand for seafood. It offers income generation and employment opportunities, particularly in coastal and rural communities. Furthermore, aquaculture in the tropics contributes to diversifying the available seafood options, reducing pressure on wild fish stocks, and providing a consistent source of protein for local populations. The production of fry for restocking overharvested wild populations is becoming an important strategy to keep fisheries going, supporting an important sector of the population at work. However, it is important to note that tropical aquaculture also faces specific challenges, such as disease outbreaks, increasing environmental impacts, and the need for sustainable management practices (Leung & Bates, 2013). Proper water quality management, disease prevention measures, responsible feed sourcing, and the implementation of appropriate aquaculture systems are crucial to ensure the sustainability and long-term viability of tropical aquaculture operations.

Advances in technology and practices applied to aquaculture have been fundamental in improving production. These improvements include enhanced feed formulations, disease management strategies, water quality monitoring systems, genetic selection, and integrated multi-trophic aquaculture practices. However, most of these improvements have been implemented in temperate zones; more efforts are needed to include them in the tropics, where the practices are still extensive or semi-intensive.

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Sustainability has become a key focus in the aquaculture industry, and efforts are being made to minimize the environmental impact of aquaculture through responsible farm management, reduced reliance on wild fish for feed, efficient resource utilization, and adoption of certification and labeling schemes that promote sustainable practices. It is important to observe that aquaculture production can vary significantly from year to year, particularly influenced by factors such as strong climate events, disease outbreaks, market dynamics, and regulatory changes (Troell *et al.* 2017). Implementing the most effective practical methods of reducing environmental impacts from aquaculture, making them compatible with resource management goals, will be determinants for sustainable aquacultural practices (Boyd et al., 2008). Aquaculture in the tropics can have significant environmental implications. Excessive use of antibiotics and chemicals, improper waste management, and the release of non-native species can harm local ecosystems. To minimize these negative impacts, it is essential to implement sustainable practices, such as efficient water management, disease prevention, and proper waste treatment. Due to higher water temperatures and the increased pathogen presence in the tropics, disease outbreaks can have devastating consequences on farms, leading to significant economic losses. Adequate biosecurity measures, including regular health monitoring, vaccination, and quarantine protocols, are crucial to prevent and control disease outbreaks. Therefore, ensuring the sustainability of tropical aquaculture is vital for the industry's long-term viability. Certification schemes, such as the Aquaculture Stewardship Council (ASC) and Best Aquaculture Practices (BAP), provide guidelines for responsible farming practices and help consumers make informed decisions. Encouraging observance of these standards promotes environmentally friendly production methods and social responsibility (Bush *et al.* 2013). However, such certifications are complex and expensive, requiring strong administrative capabilities.

There is no doubt that tropical aquaculture is playing a significant role in global aquaculture production and has a strong potential for growth, offering various benefits such as species diversification, increased production, economic development, and enhanced food security. However, expanding aquaculture in the tropics faces huge challenges. Avoiding environmental impacts, disease outbreaks, antibiotic use, and genetic interactions between wild and captive populations are important sustainability concerns. Industry stakeholders, policymakers, farmers, and researchers must collaborate in developing and implementing sustainable practices to maximize the positive impacts of tropical aquaculture while minimizing its negative effects. By doing so, tropical aquaculture can draw a bright future, impacting global food security and economic development while preserving the health and integrity of aquatic ecosystems. We, the researchers, have a significant role in making aquaculture a sustainable and responsible industry; our efforts must enlighten the path for future generations of aquaculturists.

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